CALIFORNIA DIVISION OF MINES AND GEOLOGY

FAULT EVALUATION REPORT FER-139

February 17, 1981

1. Name of faults.

Big Lagoon, Bald Mountain, Grogan, Lost Man, Surpur Creek and related, unnamed faults, northern Humboldt and southern Del Norte Counties, California.

2. Location of faults.

Fern Canyon, Orick, Rodgers Peak, Crannell, Blue Lake, Lord Ellis Summit, Korbel, Maple Creek, Grouse Mountain, Mad River Buttes, Board Camp Mountain, and Requa 7.5-minute quadrangles, and Ship Mountain, Tectah Creek, and Coyote Peak 15-minute quadrangles (see Figure 1).

3. Reason for evaluation.

Part of an 11-year program to evaluate potentially active faults in California and zone those faults which are sufficiently active and well-defined (see Hart, 1980).

4. References.

Aalto, K.R., Cashman, P.H., Cashman, S.M., and Kelsey, H.M., 1981, Geology of the Coast Ranges, Del Norte and northern Humboldt County, California: Unpublished mapping for the California Division of Mines and Geology, scale 1:24,000 and 1:62,500.

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Earth Sciences Associates, C 1976, Humboldt Bay Power Plant site geology investigation: Unpublished consulting report for the Pacific Gas and Electric Company, 101 p., 36 figures, 19 plates, 8 appendices (variously paginated).

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Herd, D.G., 1978, Intracontinental plate boundary east of Cape Mendocino, California: Geology, v. 6, p. 721-725.

Irwin, W.P., 1960, Geologic reconnaissance of the Northern Coast Ranges and Klamath Mountains, with a summary of the mineral resources: California Division of Mines Bulletin 179, 80 p., 1 plate, scale 1:500,000.

Jennings, C.W., 1975, Fault map of California with locations of volcanoes, thermal springs, and thermal wells: California Division of Mines and Geology, California Geologic Data Map No. 1, 1:750,000 scale.

Manning, G.A., and Ogle, B.A., 1950, Geology of the Blue Lake quadrangle, California Division of Mines Bulletin 148, 36 p., 3 plates, scale 1:62,500.

Real, C.R., Toppozada, T.R., and Parke, D.L., 1978, Earthquake epicenter map of California: California Division of Mines and Geology Map Sheet 39, scale 1:1,000,000.

Ristau, D., 1979, Unpublished geologic maps of various quadrangles: California Department of Forestry, 1:62,500 scale.

Silver, E.A., 1971, Transitional tectonics and late Cenozoic structure of the continental margin off northernmost California: Geological Society of America Bulletin, v. 82, n. 1, p. 1-22.

Strand, R.G., 1962, Redding sheet: California Division of Mines and Geology, Geologic Map of California, Olaf P. Jenkins Edition, scale 1:250,000.

Talley, K.L., 1976, Descriptive geology of the Redwood Mountain outlier of the South Fork Mountain Schist, northern Coast Ranges, California: Unpublished M.S. thesis, Southern Methodist University, 86 p., scale 1:62,500.

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Young, J.C., 1978, Geology of the Willow Creek quadrangle, Humboldt and Trinity Counties, California: California Division of Mines and Geology Map Sheet 31, 16 p, 1:62,500 scale.

5. Summary of available data.

The Big Lagoon, Bald Mountain, Grogan, Lost Man, Surpur Creek, and related faults lie in a region that has not been mapped in great detail. Our understanding of the regional tectonics has changed greatly in the last few years as the result of work by Herd (1978) and Woodward-Clyde (1980) in the onshore areas, and Field and others (1980) offshore. Detailed geologic maps have only been published for two of the 15-minute quadrangles in the area studied: the Blue Lake (15-minute) quadrangle (Manning and Ogle, 1950) and the Willow Creek quadrangle (Young, 1978). In addition, Aalto and others (1981), Ristau (1979), and ~~Nolan~~ Harden and others (19~~78~~81) have compiled geologic maps of all or part of the area based on aerial reconnaissances and unpublished data. At the time this FER was completed,
the Ristau maps covering the Weed 1:250,000 were not available for review. Aalto and others did consider the Ristau maps in their efforts, however.

All of the faults evaluated in this FER are subparallel with and northeast of a zone of northwest-trending, northeast-dipping, recently active thrust and reverse faults (Carver and others, 1982) evaluated in FER-138. The faults evaluated in this FER are probably also mostly northeast-dipping thrust or reverse faults, several of which cut Quaternary deposits. The available data on each are discussed below.

Big Lagoon fault

The Big Lagoon fault is an 11-mile long, north-striking fault which cuts Quaternary (undifferentiated) marine deposits near Big Lagoon (Aalto and others, 1981). Aalto and others do not provide any information as to the dip or sense of displacement of this fault. They show the fault as concealed beneath marine terrace deposits at its southernmost extent, near the junction with the Patricks Point fault.

Talley (1976) considers the Big Lagoon and Patricks Point faults to be surface traces of the same thrust fault which underlies the Patricks Point outlier (Franciscan). Using his interpretation, the Big Lagoon fault is a west-dipping thrust and the Patricks Point fault is an east-dipping thrust. The latest movement on the latter fault is thought to pre-date the Patricks Point marine platform (Aalto and others, 1981) which is about 82,000 years old (Coppersmith, 1980, p. B-39). The youngest unit cut by the Patricks Point fault is Franciscan material.

Earth Sciences Associates (1976), in a regional compilation, depicted the Big Lagoon fault as extending southward merging with their Mad River fault zone (Herd's, 1978, Hayward-Lake Mountain fault system). Carver and others (1982) have mapped several of the major, recently active faults included in the Mad River zone as east-dipping thrusts. The hypothesis that the Big Lagoon fault is an east-dipping thrust or reverse fault would appear to be more compatible with the outcrop pattern mapped by Aalto and others along the eastern margin of Big Lagoon than would Talley's west-dipping thrust hypothesis.

Bald Mountain fault

Manning and Ogle (1950) named the Bald Mountain fault, describing it as a thrust fault which has been offset by innumerable cross faults (as shown in simplified fashion in Figure 1). Talley (1976) depicted the Bald Mountain fault as a west-dipping thrust fault which forms the western margin of the Redwood Mountain outlier and has an apparent sinuous outcrop pattern in plan view, lacking the cross faults. Neither Harden and others (1981) nor Aalto and others (1981) provide ~~no~~ any information on the dip or sense of displacement along the

Bald Mountain fault. Ristau (1978) essentially modified Manning and Ogle's map, depicting the fault as a thrust offset by cross faults. Ristau also depicts the trace of the fault as bending eastward at its southernmost extent, becoming the Grogan fault, as do Irwin (1960) and Strand (1962). No sources reviewed show the Bald Mountain fault as cutting any unit younger that the Franciscan, although no pre-Holocene deposits capping the fault have been identified.

Grogan fault

Manning and Ogle (1950) named the Grogan fault, describing it as a thrust along which Kerr Ranch Schist (South Fork Mountain Schist) had been displaced over Franciscan material. Talley (1976) described the Grogan as a steeply east-dipping reverse fault. He hypothesized that the Grogan and Bald Mountain faults are surface traces of the same thrust fault which has subsequently been folded into a synform, overturned on the eastern margin. Aalto and others, (1981) indicate that the fault cuts Plio-Pliestocene marine and non-marine deposits informally known as the Gold Bluffs formation, while Harden and others (1981) depict the fault as concealed beneath these deposits. I recall that Dr. John Young (formally at Humboldt State University) routinely took his field classes to view Franciscan materials overlying (in fault contact with) Gold Bluff deposits. Talley (1976, p. 63) confirms my recollection, although he considers the Grogan to be more clearly a shallow-dipping feature and assigns the name Redwood Creek fault to the more vertically dipping fault. Talley also reports that Young had found evidence of oblique-slip movement on this (the more vertical) zone. Aalto and others (1981) depict only one fault - the Grogan - in this area, while Harden and others (1981) show the Grogan as two subparallel faults over much of its length. Jennings (1975) depicts the Grogan in black (no evidence of Quaternary movement), but shows a fault offshore, on trend with the Grogan, as Quaternary.

Unnamed fault A

Unnamed fault A, located between the Grogan fault and the Bald Mountain fault, has only been mapped by Aalto and others (1981). They do not indicate dip of the fault, but do show it as having an apparent down-on-the-east sense of displacement. They also show it as cutting a marine terrace (elevation about 560 ft.) of unknown Quaternary age.

Lost Man fault

The 10-mile long Lost Man fault is known to displace Plio-Pleistocene Gold Bluffs formation, but is evidently capped by Pleistocene gravels deposited by an ancestral Klamath-Trinity river (Aalto and others, 1981). The apparent sense of displacement is west side down, but the amount of displacement and dip of the fault are not reported by Aalto and others. The outcrop pattern mapped by Aalto and others suggests that the fault is near vertical and that vertical displacement has been on the order of 350 to 500 feet since deposition of the Gold Bluffs formation.

The northern end of the Lost Man fault as mapped by Aalto and others (1981) is concealed by Pleistocene gravels. About one-half mile to the north, Aalto and others show another fault almost on trend with the Lost Man fault, but they did not infer the two are connected. (This northern, unnamed fault is shown as concealed in places by Pleistocene deposits.) Instead, it appears the Lost Man fault continues beneath these Pleistocene gravels to the coast based on bedrock geology.

Unnamed fault B

Unnamed fault B is depicted by Aalto and others as about two miles long, and as cutting Pleistocene gravels. Although they do not indicate the dip of the fault, they do indicate that the sense of displacement is west side down, and that Pleistocene alluvial gravels are offset.

Surpur Creek fault

The Surpur Creek fault cuts both the Gold Bluffs formation (Plio-Pleistocene) and Pleistocene continental deposits near its southern end (Aalto and others, 1981). The amount of apparent vertical (down to the west) displacement is not clear, but is probably less than 200 feet (post-gravels) and may offset the Gold Bluffs by as much as 400 feet. The dip of the fault is not noted on their map. Much of the central segment of the fault is inferred by Aalto and others. The fault does not appear to cut terrace gravels present along the Klamath River. These gravels may be either Holocene or late Pleistocene in age.

Unnamed fault C

Unnamed fault C is depicted by Aalto and others (1981) as offsetting Pleistocene gravels by as much as 500 to 700 feet, in places. Again, the dip of the fault is not given, but the sense of displacement is indicated as western block down. This fault is located about one mile west of and is subparallel to the Surpur Creek fault.

Unnamed fault D

Located about one-half mile east from and subparallel to Surpur Creek fault is unnamed fault D (Aalto and others, 1981). The dip of the fault is not indicated by Aalto and others, ~~but~~ and the sense of displacement is not clear from their map. It is also not clear ~~whether~~ if the fault cuts Pleistocene gravel deposits. The fault does not cut the young flood plain deposits along the Klamath River.

Air photo lineaments of Harden and others

Harden and others (1981) identified three northwest-trending and one east-trending air photo lineaments based on an apparent alignment of undrained ponds and depressions. They stated, "Although large mass movements could have formed any single undrained depression or pond, the linear trend of several features suggests they are fault related." Elsewhere, they state "... the geomorphic features that define these lineaments are similar to the geomorphic features that define active faults elsewhere."

Offshore data

As noted earlier, Jennings (1975, after Silver, 1971) depicted two offshore faults in this area as offsetting Quaternary deposits. Silver

(1971, p. 8-10) describes both these faults as northwest-trending, east-dipping thrust faults. He describes the fault, which is on trend with the Grogan fault, as separating Mesozoic rocks from a thick section of late Cenozoic deposits. He notes that northwest-trending folds appear right-laterally offset along this fault. The second fault, on trend with the Bald Mountain fault, is subparallel with the first. It, too, is a thrust fault which offsets the Wildcat Group (mostly Plio-Pleistocene in age) according to Silver (it is more likely that the Wildcat deposits referred to are actually Gold Bluffs formation based on the regional geology).

Field and others (1980) have also studied the offshore area and have identified several faults which are subparallel to the two identified by Silver. Several of the faults Field and others detected are interpreted as cutting Pleistocene deposits. These include faults on trend with the Grogan fault and either the Bald Mountain or Big Lagoon faults (see Figure 1 for a summary of the Field and others data).

6. Seismicity.

As noted by Field and others (1980), the study area is seismically active but the type of motion associated with major earthquakes is largely unknown. Bolt and others (1968, pp. 1728 and 1744) analyzed data available for a M 5.6 earthquake which occurred on 23 August 1962 off Crescent City. They concluded that the first motion data indicated right-lateral movement probably occurred along a northwest-trending fault. Silver (1971, p. 13) speculated that the fault he depicts off Point St. George caused the 1962 earthquake. During the period from 1900 through 1974, most of the earthquakes in the region larger than M 4.0 appear to have occurred in the area southeast of the Bald Mountain fault (Real and others, 1978).

7. Air photo interpretation

Black and white aerial photos, scale 1:90,000, flown in 1974 (probably by Fairchild Aerial Surveys) were interpreted in order to detect any obvious evidence of recent fault movement. Although more detailed photos may be considered desirable, the recently active Trinidad and McKinleyville zones* were quite obvious on these photos (see prints HUM 18-3 and 18-7, for example).

No detailed air photo interpretive map was prepared. The results are summarized below.

Big Lagoon fault

The Big Lagoon fault was not an obvious, major feature on the photos (prints HUM 18-11, 15, and 19). Although the course of Maple Creek may be grossly controlled by the Big Lagoon fault, many of the tributary streams which cross the fault mapped by Aalto and others (1981) do not appear deflected. Elsewhere, the deflections are not consistently in one direction. No evidence of recent vertical displacement along the Big Lagoon fault was observed.

Bald Mountain fault

The Bald Mountain fault appears to be fairly well expressed locally where the bedrock on either side of the fault greatly contrasts. For example, in the area southwest of Rodgers Peak (Rodgers Peak quadrangle), the fault is evident as a break in slope. Elevations of the mountain tops southwest of the fault in this same area are fairly uniform and much lower than mountain tops northeast of the fault. Even so, no features were observed that suggest Holocene or late Pleistocene movement has occurred along the northern segment of the Bald Mountain fault (prints HUM 18-3, 7, 11, 15, 19, and 23).

*evaluated in FER-138.

Grogan fault

The Grogan fault does not appear to be well expressed at its northern end. Near Major Creek (Orick quadrangle) the fault is locally well expressed in a clear cut area. However, no systematically offset drainages or similar features were observed that would suggest recent fault movement has occurred along the Grogan fault (prints HUM 18-19, 23, 27, 31, and 35).

Unnamed fault A

Unnamed fault A (prints HUM 18-27, 31, and 35) appears reasonably well expressed, marked by linear drainages. No clear evidence suggesting Holocene movement was apparent, however.

Lost Man fault

The Lost Man fault is fairly well expressed east of Elk Prairie (Orick and Tectah Creek quadrangles) as a sharp break in slope (see prints HUM 18-31 and 35). To the north, this break in slope appears to die out. Streams crossing the fault do not appear systematically laterally deflected. In the area where the fault is best defined, it appears to be a thrust fault (based on the configuration of the surface trace and areal topography), which rather abruptly dies out to the south (or has not been mapped by Aalto and others). This fault appears to be the best expressed of those faults evaluated in this FER. There is some suggestion that a similar thrust, having a smaller displacement may exist on the western edge of Holter Ridge (Tectah Creek and Coyote Peak quadrangle). No clear evidence of Holocene movement was observed, although the Lost Man fault could (based on its surface expression) be late Pleistocene or younger.

Surpur Creek fault, unnamed faults C and D

Neither the Surpur Creek fault nor unnamed faults C and D appear well expressed on the photos (prints HUM and DN 18-31, 35, 39, and 48). Streams do not appear systematically deflected, and no topographic break is obvious, although streams may locally be fault controlled.

Air photos lineaments of Harden and others

The air photo lineaments identified by Harden and others (1981) as being similar to aligned geomorphic features that are normally found along active faults were not well expressed on the air photos. Drainages did not appear to be systematically offset along any of the lineaments, although several ponds are present along one lineament, and several drainages appear aligned along another.

7. Field observations.

Due to constraints on travel funds and time, no field observations were made for this FER.

8. Conclusions.

Offshore data suggests there may be three faults of Pleistocene or younger age in the study area. The data on hand are insufficient to determine how the onshore and offshore faults connect or relate to one another, however.

There are no field data available that indicate that any of the onshore faults or lineaments evaluated herein are Holocene in age. The Big Lagoon and Surpur Creek faults, as well as unnamed faults A, B, and C appear to have been active during Pleistocene time based on offset stratigraphic units. The Grogan and Lost Man faults both appear to have been active during the Plio-Pleistocene based on offsets of Gold Bluffs deposits. Also, stratigraphic relationships indicate that the latest movement on the Big Lagoon, Lost Man, and (possibly) Surpur Creek faults predates the Holocene since Pleistocene units are not offset locally. The Bald Mountain fault and unnamed fault D can only be dated as post-Franciscan in age. The lineaments of Harden and others (1981) have not been clearly identified as faults.

Except for the Lost Man fault, the faults evaluated herein are either not well defined or only locally well defined. The Lost Man fault appears to be a reasonably well defined fault, probably a low angle thrust. It may well be, based primarily on the surface expression, that the Lost Man fault has been active (at least along part of its length) during latest Pleistocene or, possibly, Holocene time despite the fact it is concealed by gravels at its northern end. Based on the pattern of faulting present in the McKinleyville area (Carver and others, 1982), the seismic events near Crescent City, and a nearby Pleistocene offshore fault, this would not be an unreasonable hypothesis.

9. Recommendations.

Based on the data summarized above, do not zone any of the faults or lineaments evaluated herein at this time since none appears to meet the criteria of sufficiently active and well defined (see Hart, 1980). Because of the fairly well-defined nature of the Lost Man fault along most of its length, this fault should be considered suspect. However, since it lies in a remote area and is almost entirely on state and federal parkland, and because of project limitations, further evaluation of the Lost Man fault is not recommended at this time.

10. Investigating geologist; date.

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RG 3445, CEG 1029
February 17, 1981

I concur with recommendations.
EWH
10/12/82